69
CE

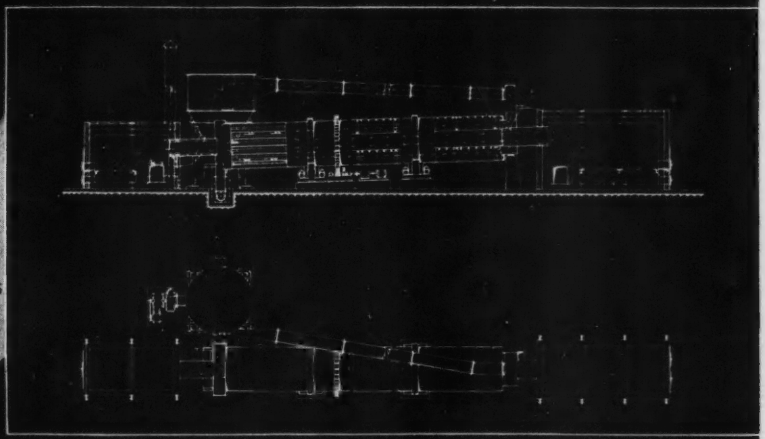
CEMENT AND LIME MANUFACTURE

LIBRARY
UNIVERSITY OF WASHINGTON
JUN 24 1941
SEATTLE, WASHINGTON

L. XIV. No. 5 MAY 1941 PRICE 1/- MONTHLY

AS MODERN AND BRITISH AS THE

NEWELL'S
Cement MAKING PLANT



Send for details of the new Dryer specially developed for drying Granulated Blastfurnace Slag.

ERNEST NEWELL & CO. LTD
MISTERTON via DONCASTER

Specialists in Cement Plant since 1903

PUBLISHED BY CONCRETE PUBLICATIONS LTD., 14, DARTMOUTH STREET, LONDON S.W.1

To Employers in the Building, Civil Engineering & Allied Trades

WE WANT YOU TO TALK TO YOUR MEN

on behalf of your country

YOU hold your positions as heads of businesses by your ability and your natural gift as *leaders*. This special quality can be of greater value than ever at this time of great need. We want you to lead your men into the way of *SAVING*. We want you to create in your works or factory a live and enthusiastic SAVINGS GROUP.

If a Group has already been formed, we want you to put your personal "drive" behind it. Men respond to encouragement. Please talk to your men on your country's behalf. Inspire them to greater effort. Provoke a spirit of sporting competition. Create records and keep breaking them. Enthusiasm is necessary to win *VICTORY*.

TALK TO YOUR MEN TO-DAY

HOW TO START A SAVINGS GROUP

It is not difficult or complicated. Leaflets published by the National Savings Committee explain just what to do. It is simple. The important thing is to get into touch with your Regional Commissioner or your Local Savings Committee AS SOON AS POSSIBLE. You will get all the personal help you need.

INSPIRE ENTHUSIASM

1 Emphasize Saving as the citizen's duty to his country in time of war.

2 Explain that to buy weapons we must pay cash—the more we save, the more cash we have to buy them.

3 Point out what men in other firms in your industry are doing—don't let your men lag behind.

4 Point out how valuable these Savings will be when Peace is restored.

5 Tell your men of the interest their savings will earn. Explain that War Savings are the safest of all investments.

6 Say, too, how easy it is to save — especially if they arrange that a sum be deducted each week from wages.

ISSUED BY THE NATIONAL SAVINGS COMMITTEE

CEMENT AND LIME MANUFACTURE

PUBLISHED 20TH OF EACH MONTH. PRICE 1/- A COPY. ANNUAL SUBSCRIPTION 12/- POST FREE

PUBLISHED BY
CONCRETE PUBLICATIONS LIMITED
14 DARTMOUTH STREET, LONDON, S.W.1

TELEPHONE: WHITEHALL 4581.
TELEGRAPHIC ADDRESS:
CONCRETIUS, PARL, LONDON

PUBLISHERS OF
"CONCRETE & CONSTRUCTIONAL ENGINEERING"
"CONCRETE BUILDING & CONCRETE PRODUCTS"
"CEMENT & LIME MANUFACTURE"
"THE CONCRETE YEAR BOOK"
"CONCRETE SERIES" BOOKS, ETC.

VOLUME XIV. NUMBER 5 MAY 1941

Comparative Methods of Grinding Cement.

A DIFFERENCE of opinion has existed for a number of years regarding the relative merits of the various methods of grinding cement. Although each method has its own advocates, and may be the best as seen from their point of view, it is possible that a different view would result if a broader outlook were taken. In this article the various methods are considered from a general standpoint, and an endeavour is made to take an impartial view with the object of arriving at the true facts. The following three methods are especially considered:

(*a*) Single-stage grinding (compound mill),
(*b*) Two-stage grinding (ball and tube mills), and
(*c*) Single-stage grinding with separator classification.

For the purpose of this article it will be assumed that the user will call for two main products, one having a residue of 5 per cent. and the other a residue of 0·5 per cent. on the 170-mesh sieve; also, that it will be frequently necessary to change from one product to the other to deal with small quantities and then back to the original product.

The difference in power, or in mill time, in actually grinding these two products may be assumed to be, say, 1·7 to 1·0, or say 0·6 to 1·0; that is to say, a cement that has a residue of 0·5 per cent. on the 170-mesh sieve will require 1·7 times the time or 1·7 times the power to grind than a cement having a residue of 5 per cent. on the same sieve. This ratio, however, presupposes that the media used is equally suitable for each duty. The various procedures to be considered may be more fully defined as follows.

(a) Single-stage Grinding.

In this system the work would be carried out in a simple and single mill

without any elaborate fittings. The clinker would be fed in at one end, ground, and discharged as finished cement at the other end. The media at the feed end would be large enough to break up the largest pieces of clinker in the feed, and the media at the finishing end small enough to produce economically the lowest residue required.

As the mill is not required to operate as a crusher, the largest pieces of clinker should pass freely through a hole not greater than 0·375 in. diameter; under these conditions the largest media need not be greater than, say, 3½ in. to 4 in. diameter. It need hardly be pointed out that the use of balls and media of larger dimensions than necessary results in inefficiency and unnecessary wear.

The total length of the mill may be divided into a reasonable number of compartments. The number considered appropriate for various lengths of mill are: For a length of 28 ft. to 33 ft., say three chambers; for a length of 34 ft. to 40 ft., say four chambers; for a length of 42 ft to 50 ft., say five chambers. Lifter diaphragms would be interposed between adjacent chambers; the slots in the diaphragm at the end of the first chamber should not be wider than ⅛ in. or 3 mm. The length of the first chamber should be about (or nearly) 30 per cent. of the net length of the mill.

Some single-stage mills are fitted with an external sieve or screen through which the grit must pass before it can enter the second chamber. This ensures that the feed for the second chamber does not exceed a predetermined but small dimension; it should also prevent any nibs from reaching the finished product. The arrangement, however, adds a complication and a possibly undesirable feature to what is—or should be—regarded as a simple mill.

If a mill of this type must be considered, every possible facility should be provided for the inspection and renewal of the sieves and, apart from the removal of the outer casing, it should not be necessary to remove any other part in order to change or remove any one part.

(b) Two-stage Grinding.

This type of grinding may be carried out in separate ball and tube type units wherein the ball mill is the first-stage unit. This mill would be fitted with sieves or screens through which the grit would pass on its way to the secondary or finishing mill. Mills of the ring-roll, Griffin, Hercules, and also the rod mill type, and other similar mills, are not considered in this article.

In order to obtain full advantage of the sieving principle of the ball mill, it is most important to fit the sieve plates and their framings so that there is no possibility of leakage taking place.

The ball mill, as used for a preliminary mill, is usually of large diameter and of relatively short length. The sieve frames, which are made the full width of the mill and fitted in short girth-wise sections, are wrapped around the girth of the mill and are fixed to and rotate with it. A fixed and dust-tight outer casing encloses the whole, and the grit is collected in the bottom of the casing and conveyed away.

The sieves are usually arranged in two stages. The inner sieve, with large

holes, acts as a protecting element for the outer and finer sieve, and grit that will not pass either sieve is passed back into the mill for further grinding. The effective surface extends over the full girth and width of the mill and the whole area is useful. Return is operative over the full width also.

An alternative arrangement of sieving surface is that wherein the sieves are made in the form of small cylinders fixed to the outer diameter of the mill having their axes parallel to the mill axis ; three, four, five, and even six such cylinders can be accommodated in this way and may comprise a set. Grit from the mill is led to and enters one end of the cylinders and is conveyed to the other end by means of an internal spiral ; the " fines " pass through, and the over-size is returned to the mill for further grinding. This equipment is also enclosed in a dust-tight casing. This arrangement is more suitable for large than for small units. The screening equipment appears to be less troublesome than that of the standard ball mill and is more easily kept proof against leakage.

Two-stage mills are usually operated as a pair and the power absorbed by the preliminary unit is, say, 20 per cent. of the total ; this division of power, however, is more or less arbitrary.

Second-stage tube mills of considerable size can usefully be divided into two or more chambers in the same way as those at the finishing end of large compound single-stage mills.

(c) Single-stage Grinding with Separator Classification.

This equipment generally comprises a compound mill and separator classifier. The mill usually has one or two chambers less than a similar mill working without a separator (no reason is assigned for this). The media is of a generally larger size, or, to put it another way, a smaller proportion of small size media is usually used (the total weight, however, is the same).

The product is usually classified as it leaves the mill, the " fines " being passed on to the store and the over-size being put back into the mill, with the new feed, for further grinding. The total feed is possibly 150 per cent. to 200 per cent. of the new feed. The claim made for this method is that the " fines," taken from the mill earlier than they would otherwise have been, are prevented from muffling the grit that still remains in the mill. An alternative is a mill in which the grit is extracted at a stage when 50 per cent. to 60 per cent. of grinding has been effected, the extracted material being classified, the " fines " passed on to the store, and the over-size put back into the mill with the new feed. A further alternative is that in which the over-size is put back into the mill at some intermediate point which may be more appropriate for the size of grit ; a number of variations of this principle are in use in the United States.

Consideration of the problem can now conveniently follow and furnish replies to the following questions :

(1) Which of these methods promises most continuous running or the greatest percentage of running hours ?

(2) Which method produces the smallest range of particle size in the finished product ?

(3) Which system is most susceptible to the production of nibs, or permits nibs to be discharged with the finished product ?

(4) Which system is the simplest to operate ; that is to say, which will make the least demand upon the intelligence of the operator ?

(5) Which system, or what modification of the system, promises, or appears to promise, the most systematic grading of particle size in the whole product ?

(6) What modification will be necessary to change over from one product to the other ?

Referring to (5), it may be mentioned that the aggregate that will be used with the cement will not contain any " fines " though it will contain the usual quantity of " smalls." The range of particle size in the cement should therefore be such that all the interstices are filled with the largest particle size possible and at the same time ensure that the mass is well cemented together.

Comparison of Methods.

Consider now how the units referred to under (*a*), (*b*) and (*c*) will respond to the conditions numbered 1, 2, 3, etc. To keep the principal points in view, they are arranged in sequence below and amplified later.

(*a*) SINGLE-STAGE GRINDING.—

(1) Continuous running should be easily possible, as there is nothing in the mill likely to give trouble.

(2) The range of particle size should be the largest.

(3) There is a possibility of nibs being discharged with the product.

(4) Operation is very simple.

(5) The range of particle size and the grading are good.

(6) Change of feed only—no other modification is possible ; it would, however, take some time for the mill to settle down to the altered conditions.

(*b*) TWO-STAGE GRINDING.—

(1) Probable frequent stoppage for sieve renewal and due to sieve-frame leakage.

(2) Good range, but possibly not the best.

(3) Nibs are possible, but are due exclusively to broken sieves and sieve-frame leakage.

(4) Generally, operation would be simple.

(5) Grading should be good but not of the widest range.

(6) Change of sieves and change of feed.

(*c*) SINGLE-STAGE WITH SEPARATOR.—

(1) Good, but will demand good and methodical maintenance for the separator.

(2) Reasonable range but not the maximum with the 150 per cent. feed

(3) Well-nigh impossible for nibs to be produced.

(4) The separator will probably demand a high standard of adjustment.

(5) There should be no particle above a predetermined size. The amount of small particles would be limited and depend upon the amount of circulating feed. The smaller the amount of circulating feed the smaller the size of particle, and vice versa.

(6) Change of feed and whatever adjustment is necessary to the separator unit ; this will depend upon its design.

The principal points are discussed and amplified in the following.

SINGLE-STAGE UNIT.—This is of the simplest type as there is little or nothing to go wrong, and the running hours should be the maximum. Feed control alone demands attention ; if the feed is too heavy, a coarse product would result, and possibly nibs also ; if the feed is too light, the product will be too fine and possibly flaky.

After the feed has been adjusted it may take some time for the mill to settle down to the altered conditions. A really good type of feed gear—volumetric or weight, but positive—would be a great asset in operating mills of this type, and would reduce any difficulty that might arise over a change of feed.

The particle size should range from the upper limiting dimension, as determined by the test sieve, to the smallest particle that is producible and which is more or less dependent upon the size of media used at the finishing end of the mill.

TWO-STAGE UNIT.—The subdivision of duty in the ball-tube unit is as follows. Clinker of mixed classification but all having passed through a hole 0·375 in. in diameter is fed into the ball mill, which is fitted with sieves having holes 0·1 in. in diameter or equal. As 15 per cent. to 20 per cent. of the clinker is already "small," these smalls pass through the sieve and into the tube mill. The balls in the ball mill work at once on the large clinker, and the media in the tube mill works on the grit that has just been fed into it.

This combination at first sight promises high efficiency, as it appears to have many points in its favour, but upon close examination this becomes questionable owing possibly and primarily to sieve breakage and sieve-frame leakage. Improved design would probably reduce the risk of leakage from the sieve frames, but nothing would prevent occasional sieve bursts.

The product of this combination does not usually prove so good and consistent as that of the single-stage mill. It is of course possible that the 20 per cent. of grinding time, that was saved at the beginning of the finish grinding process, has not been made up.

Apart from all efficiency differences, it must be borne in mind that there are two main units instead of one, as well as a number of additional auxiliaries all of which will require the operator's attention and maintenance.

SINGLE-STAGE MILL WITH SEPARATOR.—Experience in the British Isles with this type of unit is somewhat limited, but what experience there is appears to have been made with large circulating loads or feeds and the results obtained and reported upon have usually been based upon residue rather than upon surface area.

Makers and advocates of separators usually claim that a large circulating load is necessary for obtaining the best results, and loads of and up to 150 per cent., or even 200 per cent., of the mill's capacity are usually adopted. This procedure is quite correct if residue is to be the criterion ; if, however, surface area is to be the deciding factor, then the method of operation appears quite wrong.

A consideration of the separator's operation and an examination of the product show the following :

(*a*) The upper limit of particle size in the product is well under control and adjustable over a limited range due to the design of the machine.

(*b*) The amount of " fines " or " surface " in the product is variable and invariably of lower value than that of the compound mill.

(*c*) This result (*b*) may be attributed to the reduced time the cement spends in the grinding process, or to

(*d*) The large size of the media used near the finishing end.

High surface area is produced by small-size media operating on grit over a considerable period ; there appears to be no short cut so far as time is concerned and no royal road so far as machinery and media are concerned. It may be stated that there is no rigid connection between residue on the 170-mesh sieve and the surface area per pound. Take two samples of a typical cement, both of which have a residue of 5 per cent. on the 170-mesh sieve. If one has been finish-ground by media of 1 in. diameter and the other by media of $\frac{1}{2}$ in. diameter, each for the same length of time, the latter cement will be found to contain the most surface area and to be of finer general characteristics.

In order to produce cement having a good grading of particle size from the largest permissible grit, as determined by the various test sieves, down to the smallest particle size producible, a good grading of grinding media is necessary If the media towards the end of the grinding process is too large there will be a shortage of fines and low surface area in the product ; too much heat will also be generated during grinding, and the product will possibly be flaky also.

Applying this line of thought to the single-stage mill with separator unit it will at once be clear that the media must first be suitable, and that to have a good surface area the grit must spend the maximum time in the mill and be subjected to the minimum classification ; in fact, the separator should be used only as grit-catcher or nib trap. If at all practicable, the oversize from the separator should represent only, say, 5 per cent. to 10 per cent. of the mill's net feed.

As the weight of the output of a mill must be equal to the net input, and as the fineness of product will be determined largely by the length of time of grinding, it appears that quality of product can, within a reasonable range, be determined by the rate of feed presupposing that the media is suitable and the separator used only as a grit-catcher. In any case, the procedure discussed, although possibly new, is worth thoroughly trying out, bearing in mind that " fines " and " surface " are produced by grinding and not by classification.

New Cement Works in Eire.

EARLY in 1938 two new cement works, arranged and constructed by Messrs. F. L. Smidth & Co., Ltd., were put into production in Eire. One of these works, at Limerick, has a capacity of 1,500 tons a week (75,000 tons a year); the other, at Drogheda, has a capacity of 3,000 tons a week (150,000 tons a year). In arranging the works, provision was made for doubling their capacity if required; the output of the Drogheda works has already been doubled and the additional units, uniform with the original, were put into commission in January of this year.

The size and capacity of the main production units at each works were such that it would be able to deal with the initial total output, that is to say, there was one crushing plant, one raw material grinding mill, one coal mill, one kiln, and one cement grinding mill. This resulted in rather large units in the case of the Drogheda plant, but no disadvantage appears to have resulted from this. The following description of the new works and technical data are extracted from and based on a paper read recently before the Institution of Civil Engineers of Ireland by Mr. B. K. Olsen, chief engineer of Cement, Ltd., the owners of the works.

The raw material at Drogheda is limestone and shale; that at Limerick is limestone and clay. Both materials are obtainable at or near the respective works. The limestone is relatively hard and is obtained, by blasting, from quarries having rather deep faces. The shale generally is soft enough to be obtained by the use of a small excavator, though it also has to be blasted occasionally. The clay is always soft.

Two-stage crushing is adopted at Drogheda, and single-stage at Limerick; needless to say, two-stage procedure results in the most satisfactory mill feed.

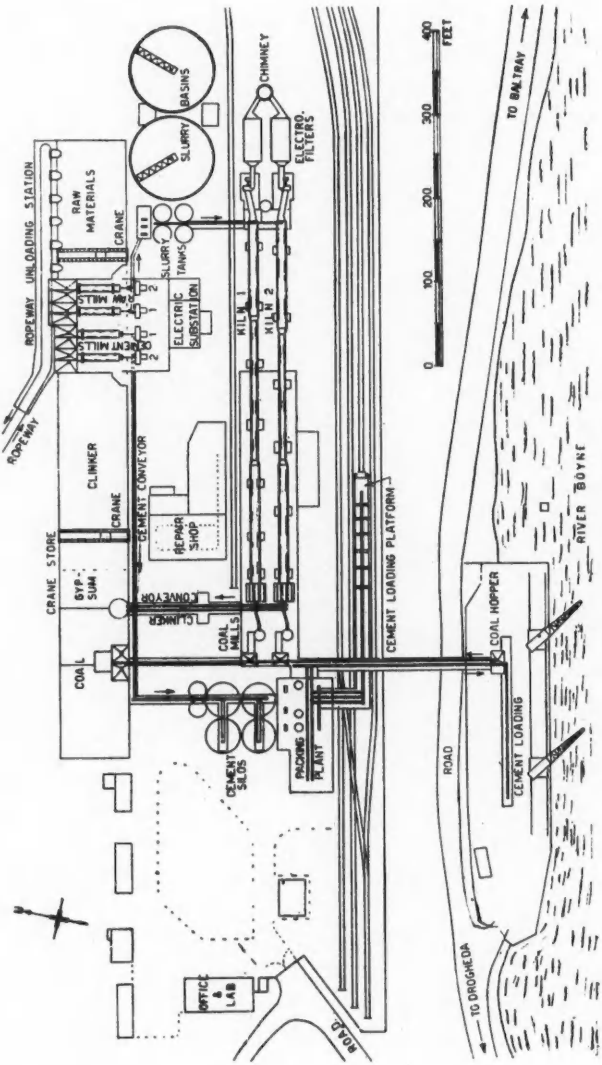
The Drogheda Plant.

The Drogheda plant is the largest and comprises the largest units. The following data refer especially to this plant.

Crushing.—The crushing plant is arranged in the limestone quarry. The quarried stone is loaded by excavators into 10-ton lorries, which in turn deliver it to the hopper at the crusher. The stone is extracted and the crusher fed by means of a laminated chain-belt conveyor which allows the "fines" to fall through. The largest pieces of stone weigh up to two tons and have a volume of up to 30 cubic feet.

The primary crusher is of the "sledging" jaw type, with a mouth opening measuring 60 in. by 48 in.; the machine is belt-driven by a 200-B.H.P. motor. The limiting size of crusher product is about 6 in. cube, and this product is conveyed to the secondary crusher by means of a second chain-belt conveyor also of the laminated type (to allow the additional fines to fall through).

The secondary crusher is of the hammer-mill type. The rotor is fitted with 48 hammers each of which weighs 84 lb. The rotor rotates at 735 r.p.m. and is driven through a friction clutch by a 325-B.H.P. motor. The limiting dimension



Plan of Drogheda Works.

of the hammer-mill product is 1 in. cube. Needless to say, the product of this machine contains a very large percentage of fines; possibly 50 per cent. of the product would pass through a ¼-in. opening. The product of the hammer mill is conveyed by a belt conveyor to one of a pair of silos which becomes the feed hopper for the buckets of the aerial ropeway for transport to the store.

Ropeway.—The ropeway is of the bi-cable type, 2¼ miles in length. Each bucket has a capacity of 25 cwt. of stone, is supported on four sheaves, and is spaced at 58-yd. intervals. One obtuse-angle station occurs in the line at about the centre of its length.

The capacity of the crushing plant and ropeway is given as 150 tons per hour. The weekly requirements of stone amount to about 5,000 tons and 10,000 tons for the production of 3,000 tons and 6,000 tons of cement respectively, and the net running hours for limestone will be, say, 35 and 70 per week.

Shale is obtained from a quarry 1½ miles from the limestone quarry. The shale is dealt with by a small excavator, taken by lorry to the limestone crushing plant, and crushed, apparently, in the same way as the limestone but in small quantities. Transport of the shale to the works appears to be effected in the same way, and it would have its own place in the works store.

Works Store.—This is of considerable area and capacity; it is used for crushed stone, shale, clinker, gypsum, and for coal for the rotary kiln. The store is served by two 10-ton girder cranes of 80 ft. span, which distribute the material when it enters the store and reclaim it for feed and charge in the various hoppers as required. One of these cranes deals with the crushed limestone and shale just referred to. The rated capacity of the store is given as 30,000 tons.

Raw Material Grinding Mills.—These mills are 8 ft. diameter by 59 ft. long, supported upon two slider rings. They are lined with heavy manganese steel lining plates, and loaded with 100 tons of grinding media. They rotate at 20 r.p.m. and are driven by a 1,400-B.H.P. auto-synchronous motor through a reduction gear and central drive. The mills are divided into five compartments with a sieve plate or slotted diaphragm interposed between adjacent compartments.

The limestone and shale each has its own hopper and feed table. The discharge of the feed tables is designed to produce the correct mix; they are driven by a variable-speed motor and any adjustment in the quantity of feed is obtained by altering the speed.

The grinding media ranges from forged steel balls of from 4 in. to 3 in. diameter in the first chamber to small cylindrical "Cylpebs" in the finishing chamber. This media is loaded in the successive chambers in groups of assorted sizes diminishing from the largest size at the feed end of the mill to the smallest size at the finishing end; a definite size classification of media is necessary for efficient grinding.

The thickness of the shell lining would be, say, 2 in. to 2½ in., which would make the effective (mill) diameter, say, 91 in. to 92 in.; the space required for the feed and discharge and the diaphragms would reduce the gross length from 59 ft. to an effective length of, say, 54 ft. Combining the figures obtained for mill volume and the charge volume, the weight of which is given at 100 tons, it appears that the designed charge volume may be about 34 per cent. to 35 per cent. of the effective mill volume. The speed is given at 20 r.p.m. and this speed, with the thickness of lining named, results in a speed factor of 190 to 195.

The reserve capacity of the motor and driving gear for this mill appears considerable. In any case it will prove difficult, if not impossible, to load the mill high enough to absorb the full power, but a little reserve power is always an advantage in mill operation.

No figures are given for output, but this would possibly be 40 or even 45 tons per hour when absorbing 1,250 to 1,300 B.H.P. with hammer crusher product as feed, with low moisture and with less than 5 per cent. residue.

Slurry.—The slurry is stated to contain "low" moisture; no figure is given, but, as it is produced from limestone and shale, the moisture may be as low as 35 per cent. to 36 per cent. of the finished product.

The slurry, as produced, is elevated to the doctor tanks (there are four of these tanks) and agitated by compressed air. When the correctness of the composition has been verified the slurry is run off into one or other of two storage basins, where agitation is effected by a combination of compressed air and mechanical agitation.

The storage basins are 100 ft. in diameter and hold sufficient slurry for five days' production, say fully 4,000 tons of clinker. The net depth of these basins appears to be something like 16 ft., which is very liberal and likely to prove useful.

Coal Mill.—The coal mill is of the "air swept" type, that is to say, coal at the correct rate is fed into the mill, ground to the required residue, and "swept" into the kiln by a current of hot air drawn from the kiln hood or similar position.

Each kiln produces clinker at an average rate of 3,000 tons a week or, say, 18 tons an hour, which is equivalent to fully 20 tons an hour over short periods. The coal-clinker rate is given at 25 per cent., so that the coal mill must be able to deal with fully five tons of coal per hour. No figures are given for moisture in the coal or ash, but both of these will have to be allowed for in assigning the gross amount of feed for the mill.

Kiln.—The kiln is 12 ft. diameter by 423 ft. long supported on six sets of rollers. No reference is made to any enlargement or to any "waisting" of the barrel, though such would probably exist. Eleven cylinders for clinker coolers and air heaters are attached to the lower, or clinker discharge, end of the kiln shell.

Assuming the diameter of the kiln given as 12 ft. to be a mean figure, a net

length of 415 ft., and an average thickness of shell lining of, say, 6 in., the internal dimensions become 11 ft. by 415 ft. and equivalent to a net internal volume of approximately 40,000 cubic feet. Assuming further that the short-period output amounts to 20 tons an hour, we arrive at an output rating figure of 10 cwt. per hour per 1,000 cubic feet of internal volume, which appears to be a very low figure. It is admitted that a number of assumptions have had to be made to arrive at this figure, but any change made in the assumed figures will still leave the figure for rating very low; probably there is some connection between the low rating and the similar low figure for coal-clinker ratio deduced at 25 per cent.

The rotary kiln is referred to in the paper as being the heart of the works; this is quite correct, and fully justifies the large equipment of indicators, gauges, etc., that form part of the installation—48 per kiln is the actual number given in the paper.

Both kilns are equipped in the same way. They are operated by and are in charge of a single attendant, and the gauge equipment enables him to keep a close watch on the kiln operation. Clinker as produced is delivered to the clinker store, where it can be handled by one of the cranes and ultimately delivered to the mill hoppers. The gypsum has its own, but smaller, hopper.

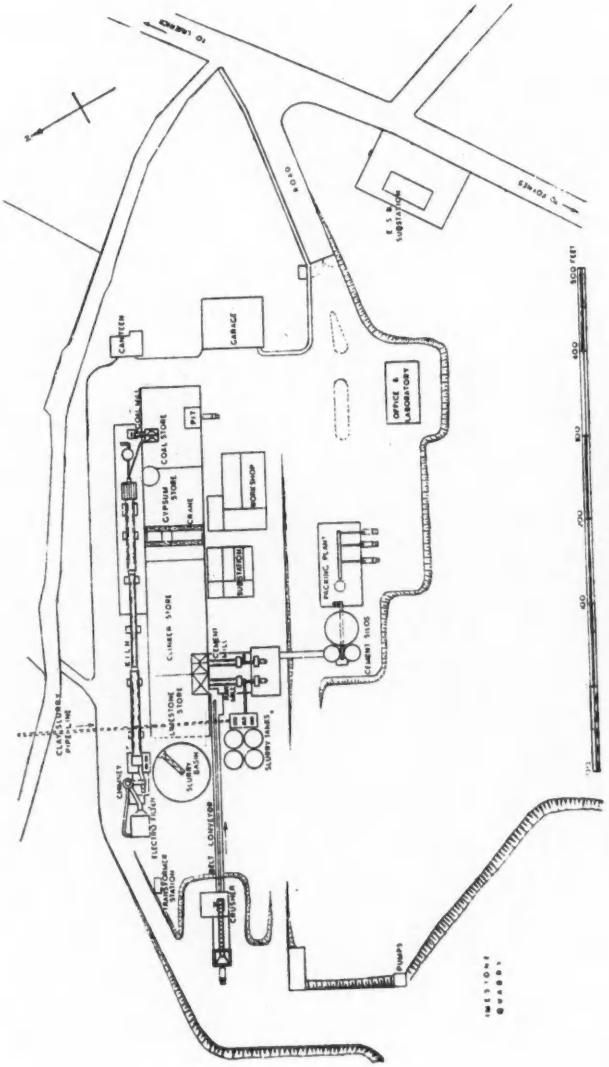
Cement Grinding Mills.—The dimensions and general design of the cement grinding mills are stated to be in agreement with that of the raw mills; they, however, are driven by a 1,250-B.H.P. motor and gear instead of a 1,400-B.H.P. motor. The charge load may therefore be less, say, 80 to 85 tons, but the classification will be the same or similar. As the charge weight is lower, the volume of the charge will be lower also, possibly 28 per cent. to 30 per cent. instead of 34 per cent. to 35 per cent. The diaphragms will be of the lifter type instead of the plain type.

No figure is given for mill output but this would possibly be 30 to 35 tons an hour and 20 to 25 tons an hour under 5 per cent. and 1 per cent. residue conditions respectively when operating at 1,200 B.H.P.

Silos and Packing.—The ground cement is conveyed to the silos by means of belt conveyors. Extraction from the silos and packing are effected by means of Messrs. Smidth's unique equipment (the "Fluxo" system) and the arrangement of conveyors and cranes enables despatch to be effected by either water, lorry, or rail.

The Limerick Plant.

Subject to the following, the arrangement and design of the Limerick plant are in general agreement with those of the Drogheda plant. The Limerick plant is smaller and smaller process units have been adopted. There is no ropeway. Limestone and clay are used as raw materials and are obtainable on or very close to the works. Limestone is crushed in a single stage by a crusher of the hammer type but of different design from that at Drogheda; the hammers are much heavier and the hammer shaft runs much slower—the machine will accept



Plan of Limerick Works.

pieces of stone weighing as much as 1 ton (15 to 16 cu. ft.), and the largest pieces in the product will not be greater than 1½ in. The general classification of the product will be similar to that of the Drogheda unit, though somewhat coarser. The kiln, which is also smaller, has the same control equipment as at Drogheda. The packing plant and its arrangement are also the same, but there is only one packer instead of three. The finished product has to be taken by road, a distance of two miles, in order to take advantage of existing rail and water transport.

Power Supply.

Electric power is used exclusively on both works and is obtained from the Electricity Supply Board through transformer stations, one of which has been built by the Board at each works. The supply is 3,300 and 380 volts, 3-phase, 50-cycles. The average load at Drogheda is 3,500 kW. and the maximum demand 5,000 kW. ; the average load at Limerick is 1,100 kW.

According to a graph given in the paper, it appears that the cement imported into Eire during the years 1934 and 1937 averaged 325,000 tons a year, and it appears probable that these new works will reduce the amount imported very largely.

"SLUGOIDS"

Regd. No. 532240

A PERFECT SUBSTITUTE FOR SMALL SIZE FORGED STEEL BALLS AT LESS THAN HALF THE COST.

SLUGOIDS are made of Rolled High Carbon Steel of special analysis and are of EQUAL LENGTH WITH DIAMETER. While they can be supplied just as cut from the special Steel Bars the HEAT-TREATED SLUGOIDS are to be recommended. The patent Heat-treatment process imparts a degree of Hardness not otherwise obtainable : Brinell Hardness No. 512 approx.

Write for Samples and Prices

HELIPEBS Ltd., GLOUCESTER, Eng.

The Pulverisation of Coal.

EXPERIMENTS are now being undertaken by the United States Bureau of Mines with a view to improving the methods of measuring the grindability of coal, and a report on the work has been issued (Report of Investigations No. 3,473, by Oliver C. Ralston, published by the U.S. Bureau of Mines, Washington).

The report states that numerous methods have been described, but many of them give only relative grindability. Here it was desired to assess the net power and show the relation between net power and new surface. To do this, a grinding machine had to be designed and built, and methods had to be perfected for extending the screen scale to the finest sizes.

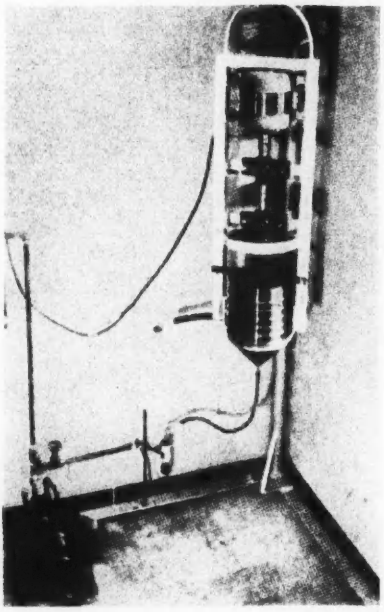


Fig. 1.—Down-draught Shaking Screen.

The grinding machine is a channel-roller batch grinder with a recorder for net power. The machine is the only grinder known to the author of the report that permits the direct recording of net power and permits dustless operation. By the use of vacuum cleaners during the grinding period, and their use in the screening on a new gyratory screening machine, no dust is lost during the tests. Dust is caught in thimbles and weighed before removal. During the grinding operation the vacuum is applied over the grinding channel, and during screening the vacuum works under the screens to draw the dust through. The channel-roller machine consists of the grinder and the recorder. The essentials of the

grinder are a horizontal revolving disc, near the periphery of which is an annular channel 11 in. in mean diameter and $\frac{3}{4}$ in. wide. The channel may be loaded with 4 to 20 gr. of minus 20-mesh coal.

The roller is of steel and has a diameter of 2 in. and a face of $\frac{1}{2}$ in. Its shaft is attached to a yoke through ball bearings, and the yoke is attached to a radius arm concentric with the shaft and carrying the revolving channel. The recorder is a cylindrical drum with accessories consisting of a clock and a stylus-carrying rack-and-pinion actuated by a reversible motor. The connection between the recorder and the grinder is made by means of a pendulum and a cord attached to the yoke of the roller. As the roller tends to advance or retreat because of the longitudinal force, which is to be measured, the electrical contacts it meets communicate with the reversible motor on the recorder and cause an analogous advance or retreat of the rack carrying the stylus. The absolute value of the record on the chart is assessed by weighing.

Heavy steel discs are placed on the roller yoke to give the amount of vertical

TABLE I.—CLOSED-CIRCUIT GRINDING OF COAL.

Charge, 8 grammes; weight on roller, 3.537 grammes; speed of channel, 33 r.p.m.; circulating load, 100 per cent.; finishing size, 150 mesh.; H.P. per ton finished = revolutions per gramme finished $\times \frac{\text{tangential force (grammes)}}{337.5}$.

Cycle	Feed, weight, percent	Products, weight, grams							
		G	H	I	J	K	L	M	N
+28.....	22.0	-	-	-	-	-	-	-	-
+35.....	23.8	0.04	0.06	0.06	0.06	0.06	0.05	0.08	0.05
+48.....	17.2	.39	.44	.45	.43	.46	.42	.48	.42
+65.....	14.5	1.25	1.31	1.33	1.31	1.34	1.29	1.42	1.32
+100.....	10.2	2.56	2.67	2.65	2.66	2.71	2.61	2.75	2.66
+150.....	9.1	3.88	4.00	4.01	4.02	4.04	3.90	4.00	3.91
-150.....	3.2	4.12	4.00	3.99	3.98	3.96	4.10	4.00	4.09
Revolutions.....	-	138	130	130	130	130	130	125	130
Revolutions per gram finished.....	-	33.5	32.5	32.5	32.5	32.8	31.7	31.3	31.8
Tangential force, grams.....	-	112	112	117	115	111	117	123	115
Hp.-hr. per ton finished.....	-	11.1	10.8	11.3	11.1	11.4	11.0	11.4	10.8

downward thrust required for comminution. From the weight of the coal, and the tangential force communicated to the drum through the cord-and-pendulum, horse-power-hours per ton are derived; and by dividing this into the units of new surface in the material, the surface-tons per horse-power-hour are ascertained. The screen performs satisfactorily, with little dust.

Those who have done batch-closed-circuit grinding know the difficulty of timing grinding periods so that the circulating load will remain balanced. Table I shows how nearly a balance can be reached, and it gives some idea of the quantitative results. The finishing was at 150-mesh.

SUPER REFRACTORIES for CEMENT KILNS

ALITE No. 1. 68% ALUMINA
Refractory Standard 3260° Fahr.
ALITE B. 57% ALUMINA
Refractory Standard 3180° Fahr.
ALITE D. 41% ALUMINA
Refractory Standard 3150° Fahr.

E. J. & J. PEARSON, LTD.,
STOURBRIDGE. ENG.

In a previous test, the feed had 14 per cent. of ash and when equilibrium was obtained the ash in the product also should have been 14 per cent. Ten cycles were required to reach this equilibrium. The ash assays of the products from the first to last cycle were 11·6, 11·8, 12·3, 12·8, 13·2, 13·3, 13·8, 13·9, and 14 per cent. Thus, the clean coal proved to be more grindable than the ash. This is confirmed by the ash content of the circulating load. At the finish of the last cycle the ash in the composite circulating load was 22·3 per cent., and the plus 48-mesh size was as much as 25·4 per cent. ash.

Some workers have little patience with sieves finer than 200-mesh. To be successful with the 270-mesh and 400-mesh sieves one must compel the manufacturers to provide satisfactory screen cloth. Even a moderately inferior screen may be corrected by applying solder where the weave is too coarse. Small openings are not objectionable, but the oversize holes must be closed. The screens should be of 3-in. diameter, and an electric vibrator should be used for screening. For finer sizes, the " Roller " pneumatic elutriator is satisfactory, but its use requires much time, skill, and training. The particle size of the elutriated product is evaluated by the " Lange " ocular photocell in conjunction with a microscope.

MISCELLANEOUS ADVERTISEMENTS.

SCALE OF CHARGES.

Situations Wanted, 1d. a word. minimum 2s. 6d. Situations Vacant, 1½d. a word: minimum 4s. Box number 6d. extra. Other miscellaneous advertisements, 1½d. a word, 4s. minimum.

Advertisements must reach this office by the 5th of the month of publication.

SITUATION VACANT.

PRODUCTION MANAGER

Required immediately with good experience in Limestone (quarrying, mining, and burning), and quarrying for Roadstone. All modern Plant, offering excellent opportunities for man of ability. Apply in first instance, giving full references, to Managing Director, NORTH ORMSBY LIME LTD., Nr. Louth, Lincs.